Writing Lab Reports

The lab report is a straightforward summary of your experiment's purpose, methods, and results.

Keep in mind that individual instructors may have a specific format or style that they require you to follow. Please be sure to consult your professor about the specifics of what to include in your lab report, and what style to follow. If you are in Biology, they may request you to use the CSE style which used to be the CBE. If you are in Chemistry, then the ACS style manual would be followed. In Health, APA is the most common style used.

The typical lab report will have:

- Title page
- Abstract, which summarizes your findings
- An introduction, which states the problem, question, hypothesis, or objective. The introduction should state why this problem is worth investigating.
- A summary of your methods, told chronologically and precisely, so that other scientists might replicate them.
- A summary of your results, in which you lay out for your readers the data that your research has generated. Again, you will want to present these results clearly, thoroughly, and precisely.
- A discussion of your results, in which you explore their significance. Even if your results haven't provided you with the information you sought, they remain important in that they might suggest other experiments to scientists interested in your subject.
- References that you used

1. The Title Page needs to contain the:

- Title and number of the experiment: Titles should be straightforward, informative, and less than ten words
- Course number and section
- Your name and student number if required
- Names of lab partners
- Date of submission
- If there are many sections and TAs, then it may be a good idea to include the name of the person you are submitting to. Everyone loves to see their name in print!

2. The Abstract When an abstract is required, the information should clearly enable readers to decide whether they need to read your whole report. The length is usually one
A paragraph of 100-200 words, but this may vary (ask your TA!). The abstract provides a concise summary of your report and summarizes four essential aspects of the report:

- **purpose** of the experiment (sometimes expressed as the purpose of the report),
- **key findings**,
- **significance and major conclusions**, and
- often also includes a **brief reference to theory or methodology**.

### 3. The **Introduction**

The Introduction is more narrowly focused than the abstract. It:

- Provides whatever background theory, previous research, or formulas the reader needs to know. It can take the form of a mini literature review, and so would include references to the work of other researchers. In this way, it contextualizes the experiment.
  *Note that usually an instructor does not want you to repeat the lab manual but rather wants you to show your comprehension of the problem.*
- States the objective of the experiment. This can take the form of a thesis statement or research question articulated in one or two sentences.
  *State the topic of your report clearly and concisely. If the amount of introductory material seems to be a lot, consider adding subheadings such as: Background, Theoretical Principles, etc.*

**Tips on using Verb Tense**

Introductions often create difficulties for students who struggle with keeping verb tenses straight. These two points should help you with writing the introduction:

- The experiment is already finished. Use the *past* tense when talking about the experiment.
  "The objective of the experiment was..."

- The report, the theory and permanent equipment still exist; therefore, these get the present tense:
  "The purpose of this report *is*..."
  "Bragg's Law for diffraction *is*..."
  "The scanning electron microscope *produces* micrographs..."

### 4. Methods and Materials (or Equipment, or Subjects, etc.)

Methods and Materials (or Equipment, or Subjects, etc.) can usually be a simple list, but make sure it is accurate and complete. In some cases, you can simply direct the reader to a lab manual or standard procedure: "Equipment was set up as in CHE 276 manual."

### 5. Experimental Procedure

- Using clear paragraph structure, explain all steps in the order they actually happened, not as they were supposed to happen as outlined in the lab manual.
• If your professor says you can simply state that you followed the procedure in the
manual, be sure you still document occasions when you did not follow the protocol
(e.g. "At step 4 we performed four repetitions instead of three, and ignored the data
from the second repetition because...").
* If you've done it right, another researcher should be able to duplicate your
experiment.

6. Results

• Are usually dominated by graphs, tables and figures
  o Graphs, tables and figures need titles and legends
• State all significant results explicitly in verbal form
  o Be sure to label each graph, table and figure, with a number, title and
    short description, and also refer to and discuss the data (graphs, tables
    and figures) in the text of the Results section.
• You can include sample calculations that will provide necessary information for
  anyone wanting to reproduce your experiment.

7. Discussion is the most important part of your report, because here, you show that you
understand the experiment beyond the simple level of completing it. Some people like to
think of this as the "subjective" part of the report. By that, they mean this is what is not
readily observable. This part of the lab focuses on a question of understanding "What is the
significance or meaning of the results?" To answer this question, use the following aspects
of discussion:

1. Analyse

• What do the results indicate clearly?
• What have you found?
• Explain what you know with certainty based on your results and draw
  conclusions

2. Interpret

• What is the significance of the results?
• How do your findings fit in with the background information on the topic or
  theoretical descriptions in your introduction?
• What ambiguities exist?
• What questions might we raise?
• Find logical explanations for problems in the data:

More particularly, focus your discussion with strategies like these:

• Compare expected results with those obtained. If there were differences, how can
  you account for them? Saying "human error" implies you're incompetent. Be
  specific; for example: the instruments could not measure precisely, the sample was
  not pure or was contaminated, or calculated values did not take friction into
  account.
Analyze experimental error. Was it avoidable? Was it a result of equipment? If an experiment was within the tolerances, you can still account for the difference from the ideal. If the flaws result from the experimental design explain how the design might be improved.

Explain your results in terms of theoretical issues. Often undergraduate labs are intended to illustrate important laws or theories. Usually you will have discussed these in the introduction. In the discussion, move from the results to the theory by explaining:

- How well has the theory been illustrated?
- Are there alternate explanations?

Relate your results to your experimental objective(s). Show that you understand the objectives of the experiment by describing your results in the context of the theory or law.

Compare your results to similar investigations. In some cases, it is legitimate to compare outcomes with those of your classmates, not to change your answer, but to look for any anomalies between the groups. *This can provide material for discussion but ask your TAs if this is appropriate first.

Analyze the strengths and limitations of your experimental design. This is particularly useful if you have designed the thing you're testing (e.g. a circuit).

8. Conclusion can be very short in most undergraduate laboratories.

- State what you know now for sure, as a result of the lab
- Justify the statement
- State the significance, if appropriate
- Suggest further research, if appropriate
- In this section you may also discuss weaknesses of experimental design, what future work needs to be done to extend your conclusions, or what the implications of your conclusion are.

9. References include your lab manual and any outside reading you have done. These should follow the style of your discipline – ACS for chemistry, CSE for biology, APA for health, etc.

10. Useful Further Reading:
Porush, David. (1995). A Short Guide to Writing About Science. (HarperCollins). This book uses the "scientific article" as the basic form for writing, it essentially views that as an extended lab report and has useful chapters on each of the sections of a lab report.